

11.—Annual *Medicago* species with particular reference to those occurring in Western Australia

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Abstract

Thirteen species of annual *Medicago* are recorded from Australia, including Western Australia—*M. arabica*, *M. intertexta*, *M. laciniata*, *M. littoralis*, *M. lupulina*, *M. minima*, *M. orbicularis*, *M. polymorpha*, *M. praecox*, *M. rugosa*, *M. scutellata*, *M. tornata*, and *M. truncatula*. Ten species are naturalized, and from four species 10 cultivars have been developed. A summary of the main generic features is given, together with keys and descriptions for species identification.

Introduction

The annual species of *Medicago*, like many other inbreeding plants, may be very variable within species and so have many infraspecific taxa, but show parallel variation and marked similarities between species. These features have resulted in a confused taxonomy. The most recent comprehensive taxonomic work on annual *Medicago* is by Heyn (1963, 1970) who showed that well over one hundred specific epithets have been applied to the 28 annual species she includes. This paper is not a taxonomic revision, and Heyn's taxonomic treatment is applied to the Australian material. Further information on taxonomy and species descriptions is given by Urban (1873, 1877), Sinskaya (1950), Negre (1956, 1959), Bolton (1962), Willis (1972), Lesins and Gillies (1973), and Quinlivan *et al.* (1974). Descriptions of cultivars registered in Australia and of some naturalized species are available in Barnard (1969, 1972).

Medics have been introduced to Australia from the Mediterranean, and the forms found here do not always show the same range of characteristics described for the species as a whole, as in Heyn (1963). This paper describes the species found in Australia and provides keys for identification of either flowering plants or burrs alone. The descriptions are based on accessions from various parts of Australia, maintained in a living collection of some 650 accessions of annual medics at the University of Western Australia. The collection also includes examples of all annual species not naturalized in Australia (McComb 1971). For all species some lines have been validated either by C. Heyn (Hebrew University), or by K. Lesins (University of Alberta). Extensive field collections have been made in Western Australia and herbarium material examined at UWA and PERTH. The synonymy found in Australian literature is listed. Only a summary of the distribution in Western Australia is given; similar

information for other Australian states may be found in Amor (1966), Andrew and Hely (1960), and Barnard (1969).

In Australia the common name 'medic' (earlier medick) is restricted to the annual species while the perennials are called 'lucerne' or 'alfalfa'. In other countries the common names medic, lucerne, or alfalfa may be applied to either perennial or annual species (Bolton 1962). The annual medics are sometimes called 'yellow trefoils' but the name 'trefoil' is also used for *Trifolium* and *Lotus* species, so the term 'medic' is preferred.

Botanical description of the annual species

Habit and vegetative parts

Annual medics germinating in late autumn, form a rosette of leaves before producing branches from the crown. The branches, which do not root at the nodes, may be prostrate and up to 1 metre long, or semi-erect and form a diffuse plant up to 40 cm high. Growth forms and branch length depend largely on environmental conditions and whether the plants are isolated or growing in a sward. Such features are therefore variable and not particularly useful in species descriptions. The outline of the stems in transverse section, as used by Negre (1956) was found to be similarly variable and has not been included.

The leaves are trifoliolate and differ from those of clovers (other than hop clovers) in that the stalk of the central leaflet is longer than that of the laterals (i.e. leaves are pinnate rather than digitate). Leaves of seedlings of *M. arabica* and *M. lupulina* may have digitate leaves but all later leaves are pinnate. Leaflet shape is variable, even on the same plant; lower leaves are usually cuneate or obovate and those produced higher on the branches more oval. Leaf morphology and measurements given in the species descriptions are based on the central leaflets of the largest mature leaves. Stipules are only very shortly adnate to the petiole as compared with species of related genera *Trigonella*, *Melilotus* and *Trifolium*, and the stipule margin is serrate, incised, or lacinate, rarely entire. Vegetative parts may be glabrous (but provided with closely appressed, small glandular hairs with short stalks which are rarely noticed unless an epidermal peel is examined under the microscope) or hairy, with simple or articulated, glandular or non-glandular hairs.

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Flowers

The flowers may be solitary, or number to 10, while one species (*M. lupulina*) has up to 50 flowers per raceme. Flowers are shortly pedicellate, bracteate, in loose racemes on an axillary peduncle which in most species is produced into an awn beyond the terminal flower. The relative length of the peduncle when it bears open flowers, and the petiole of the subtending leaf, is used as a taxonomic character.

The calyx is tubular or campanulate with five equal, or subequal lobes. Petal morphology is shown in Fig. 1. The corolla is always yellow, but there are usually purple-brown stripes in the centre of the standard. The petals occasionally have a purple tinge at the tips in young buds, or in herbarium material. 'Flower length' in the species descriptions is the length of the standard which, ranging from 2-10 mm, is longer than the wing and keel petals in all species. The relative lengths of wing and keel petals is used as a taxonomic character (cf. Figs. 11A and 16L).

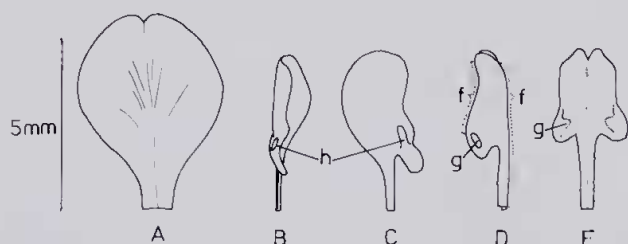


Figure 1.—Petal morphology in *Medicago truncatula*. A: Standard petal. B: edge view and C: inside view of wing petals showing the horn-like protrusion (h). D: side view and E: inside view of keel petals showing the fused edges (f) and the groove (g) into which the horn on the wing is inserted.

Nine of the ten anther filaments are fused into a sheath and one is free. Baum (1968) found that anther morphology may be used to separate the closely related genera *Medicago* and *Trigonella*. In *Medicago*, when the staminal sheath is opened out, it can be seen that the filaments arise from an arched apex, the bases of alternate filaments are swollen, and in the fused sheath there is some thickening along the vascular bundles of all, or at least the central three stamens. *Trigonella* shows two types of androecium, a 'simple' type in which the filaments emerge from a flat apex and no filaments are swollen at the base; and a 'medicagoid' type in which the filaments emerge from an arched apex, and filaments on either side of the central one have swollen bases. In neither the simple nor the medicagoid type is there any thickening around the vascular bundles. Observations on the medics which occur in Australia show that the anthers arise from an arched apex and that alternate bases are swollen, but these characters are much more strongly developed in some species (e.g. *M. truncatula* and *M. scutellata*) than in others (e.g. *M. polymorpha* and *M. minima*). In some forms of *M. lupulina* (which may also lack the 'tripping' mechanism—see below), the features are particularly poorly developed (Figure 2). The thickening

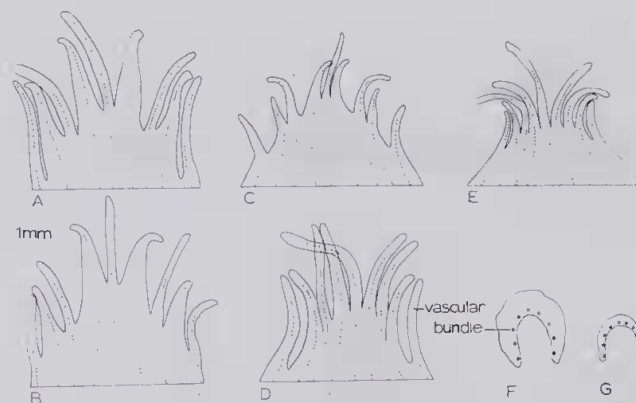


Figure 2.—Apical part of the 9 fused anther filaments in *Medicago* species. A: *M. truncatula*. B: *M. scutellata*. C: *M. polymorpha*. D: *M. minima*. E: *M. lupulina*. F: T. S. of fused filaments of *M. truncatula* and G: *M. lupulina*. (camera lucida drawings)

along the vascular bundles proved difficult to see and it is possible that the 'thickening' recorded by Baum using anther sheaths softened in lacto-phenol and flattened, results from the width of the sheath as seen in T.S. (Fig. 2).

The linear ovary has 1-28 ovules. The style which is subulate or filiform and has an oblique terminal stigma, may persist on the fruit but is never hardened into a rostrum as in *Trigonella*. The length of the floral bracts relative to the pedicel length and the calyx, as used by Negre (1956) was found to be too inconsistent, both within species and between flowers on the same plant, to be of taxonomic use.

Tripping mechanism

The flowers of the annuals are self fertile (with the possible exception of some *M. intertexta* (Lesins and Gillies 1973)), and largely self-pollinating. They lack nectaries (Heyn 1963) but are occasionally visited by insects. The perennial species have an elaborate 'tripping' mechanism for pollination which is an adaptation to cross fertilization by insects, and this tripping mechanism is retained in the annuals even though they are self pollinating. The mechanism is not found in the related genera *Trifolium*, *Trigonella* or *Melilotus*.

In the freshly-opened flower the anthers have dehisced but the pollen is contained by the surrounding keel petals. The style, surrounded by the anther filament sheath, is retained between the keel petals which are fused along their outer edges as well as for some distance along the edges facing the standard, but are free at the tips. The cohesion between keel petals results from interlocking projections on the epidermis (Larkin and Graumann 1954). The strength of the cohesion partly determines the ease with which the flower can be caused to trip. If the keel is touched so that the petals are split apart, the style and anthers are flung forward on to the standard petal. The wing petals which have horn-like protrusions appressed to grooves in the keel (Fig. 1), may be removed carefully without causing tripping, but usually movements of the wings are transmitted to the

keel and the style trips (Heszky 1972.). As the style trips a membrane is torn from the stigmatic surface making it receptive, and the pollen is pressed into the stigma (Armstrong and White 1935). The force with which the sexual column snaps over is determined by the structure of the region where the base of the fused anther filaments joins with the base of the keel petals (Larkin and Graumann 1954). When the flower has been tripped the anther filaments are curved and cannot be straightened without tearing the tissue. Non-tripped flowers do not set fruit. In the annuals self-tripping and consequently self-pollination are most common, although insects sometimes cause tripping. In countries where the species are native a low frequency of cross-pollination occurs and some species hybrids are found (Heyn 1963). In one species only, *M. lupulina*, are there some forms which lack the explosive tripping mechanism (Heyn 1963).

Fruit

The calyx is persistent, and in contrast to most clovers the corolla is deciduous. The developing coiled fruit may be contracted and concealed within the calyx (Fig. 16M); contracted but protruded sideways from the calyx (Fig. 11B); or it may hang from the calyx in a loose spiral and later become compact (Figs. 5B and 10A). These development types have been used for subgeneric divisions. One of the characteristics given by Heyn for the generic sub-sections *Rotatae* and *Pachyspirae* of the Section *Spirocarpos* 'young pods contracted and concealed within the calyx' was found to be invalid. In *M. scutellata* and *M. rugosa* the young pods protrude sideways from the calyx while in *M. littoralis*, *M. truncatula* and *M. tornata* coils could be concealed or protrude sideways in flowers on the same plant.

The mature fruit always exceeds the calyx in length and the number of pod coils ranges from 1-11. Fruits may be spiny or smooth and are indehiscent, but may gape open where the seeds are positioned. Much taxonomic weight is placed on the burr morphology and the arrangement of the radial veins on the surface of the burr, and the presence or absence of a submarginal or lateral vein along the dorsal suture (see Figs. 10B and 11F). This venation is sometimes obscure, but is best seen on the surface of a middle coil of a full size, but not fully hardened burr. Coiling direction, as determined by the direction of a line running from calyx to style, when the burr is held with the calyx end towards the observer, may be clockwise or anticlockwise. It may be typical of a species or both types may occur in the same species. In the *M. truncatula*, *M. littoralis* and *M. tornata* species group, coiling direction is controlled by a single gene, clockwise coiling being determined by the dominant allele (Simon 1965; Simon and Milington 1965). The dimensions of the burrs given in the species description are from dry mature burrs, which are smaller than freshly-picked green burrs. Measurements of diameter and height are of the coils without the spines.

Seeds

M. lupulina has only one seed, but other species have up to 28. Seeds are yellow or brown (black in *M. intertexta*), oval, kidney or horse-shoe shaped, and may be separated in the pod by false parenchymatous partitions. They are commonly impermeable, i.e. hard, when fully mature and dry. The seeds have strophioles (c.f. Hutchinson 1964) and it is usually in this region that cracks form and render the seed soft (Fig. 16K). Seed size usually decreases from the calyx to styler end with often a small misshapen seed at the styler end. Seed dimensions are based on average sized seeds.

Seedlings

The expanded cotyledons are oval or oblong-linear, the blade merging gradually into the stalk, in comparison with *Trigonella*, *Melilotus* and *Trifolium*, which have a distinct node between petiole and lamina (Fig. 3). This character is quite distinct, even though there is no difference in venation between the two types (Heyn 1968). However, I have been unable to confirm the observation that the base of the

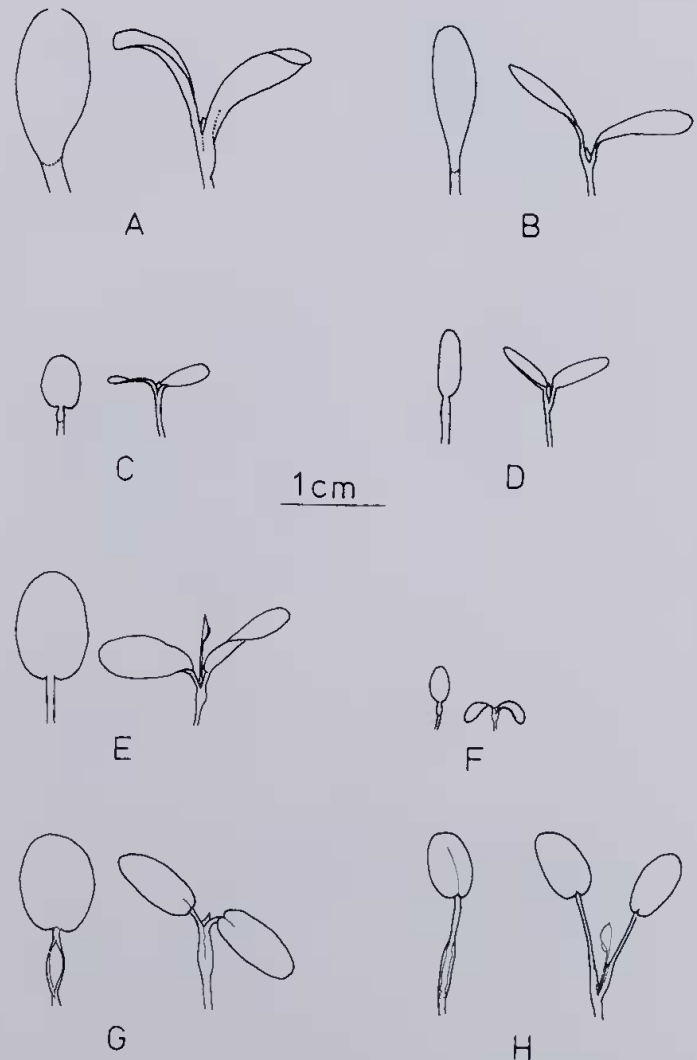


Figure 3.—Cotyledon morphology. A: *Medicago scutellata*. B: *M. polymorpha*. C: *Trigonella coerulea*. D: *T. cylindracea*. E: *Melilotus italica*. F: *M. indica*. G: *Trifolium clypeatum*. H: *T. subterraneum*.

petiole is "swollen" in *Trigonella* and *Melilotus* and not in *Medicago* (Urban 1873, quoted in Baum 1968; figured in Heyn 1963 and 1970). Species from these genera which I have grown (36 *Medicago*; 9 *Melilotus*; 11 *Trigonella*; 11 *Trifolium* species) show no basal swellings, and at most a slight bulge due to the expansion of the plumule (Fig. 3). In *Trifolium* the bases of the petioles may be fused and bulge when they enclose the developing plumule, but the thickness of the stalk is not increased at the base. It suffices therefore to distinguish only between a gradual merging between lamina and petiole, and an articulation between the two. The seedlings produce a single unifoliolate leaf, then trifoliolate leaves.

Key to species based on mature burrs

(Species descriptions are listed alphabetically)

- | | | | |
|--|-----|--|---|
| 1. Burrs spineless or with small tubercles | 2 | | |
| 1. Burrs spiny | 9 | | |
| 2. Burrs single-seeded, black, with distal end coiled | ... | <i>M. lupulina</i> | |
| 2. Burrs many seeded (rarely only one seed), coiled along full length | 3 | | |
| 3. Coils concave lower coils enclosing upper ones, burr cup- or olive-shaped | ... | <i>M. scutellata</i> | |
| 3. Coils not as above | 4 | | |
| 4. No membranous partition between seeds, burrs hairy | 5 | | |
| 4. With membranous partition between seeds, burrs glabrous or hairy | 6 | | |
| 5. Burr diameter 6-9 mm, central coils lozenge-shaped with raised veins on swollen outer margins, no lateral veins | ... | <i>M. rugosa</i> | |
| 5. Burr diameter 3-4½ mm, coils lenticular or discoid, lateral veins well separated from dorsal suture | ... | <i>M. minima</i> var. <i>brevispina</i> | |
| 6. No lateral veins, burr diameter 13-17 mm, margin of coils thin and membranous, seed coat rugose | ... | <i>M. orbicularis</i> | |
| 6. Lateral veins present, burr diameter less than 10 mm, edge of coil not thin and membranous, seed coat smooth | 7 | | |
| 7. No indentations between lateral vein and dorsal suture | ... | <i>M. tornata</i> var. <i>tornata</i> cv. <i>Tornafeld</i> and cv. <i>Murrayland</i> | |
| 7. With indentations between lateral vein and dorsal suture between bases of vestigial spines | 8 | | |
| 8. Lateral veins close to dorsal suture, groove narrow and deep, 15-20 strongly curved radial veins, burr 2½-8 mm high | ... | <i>M. polymorpha</i> var. <i>brevispina</i> | |
| 8. Groove wider and shallow (in part obliterated in very thickened burrs), about 10 radial veins almost straight, burr 6½-11 mm high | ... | <i>M. truncatula</i> cv. <i>Cyfield</i> and naturalized material | |
| 9. Burr coiling clockwise | ... | | <i>M. truncatula</i> cvs. <i>Cyprus</i> and <i>Hannaford</i> and naturalized material |
| 9. Burr coiling anticlockwise | 10 | | |
| 10. Burrs without partitions between seeds | 11 | | |
| 10. Burrs with partitions between seeds | 13 | | |
| 11. Seeds black, burrs 10-14 mm diameter, long entangled spines like a sea urchin | ... | | <i>M. intertexta</i> var. <i>intertexta</i> |
| 11. Seeds brown or yellow, burrs less than 7 mm diameter | 12 | | |
| 12. Burr 5-6 mm wide x 5-7 mm high, broad dorsal suture, radial veins entering lateral veins and a deep groove between lateral veins and dorsal suture | ... | | <i>M. laciniata</i> var. <i>laciniata</i> and var. <i>brachyacantha</i> |
| 12. Burr 3-5 mm wide x 2½-5 mm high dorsal suture narrow, radial veins enter lateral veins which are separated from dorsal suture by a broad margin (± ½ width of coil) across which run the veins to the spines | ... | | <i>M. minima</i> var. <i>minima</i> |
| 13. Coil edge with 3 grooves and 4 ridges (2 lateral furrows and a central furrow bisecting the dorsal suture); radial veins ± 8, radicle more than ½ as long as cotyledons | ... | | <i>M. arabica</i> |
| 13. Not as above | 14 | | |
| 14. Coils strongly appressed when mature | 15 | | |
| 14. Coils not strongly appressed | 17 | | |
| 15. Lateral veins in the same plane as the dorsal suture on the edge of the coil, no indentations between lateral veins and dorsal suture, burrs glabrous at maturity, spines long (up to 4 mm) inserted at 130° in middle coils, and 90° at apex. | ... | | <i>M. littoralis</i> var. <i>littoralis</i> |
| 15. Lateral veins on the surface of coil, indentations between lateral veins and dorsal suture between spines bases (especially when young, and seen in all but the most thickened burrs at maturity) | 16 | | |
| 16. Burrs 4½-10 mm high, 3-7 coils, spines 1-3 mm long, inserted at 120°-90°, burrs with scattered hairs. (pubescent when young) | ... | | <i>M. truncatula</i> cv. <i>Jemalong</i> , cv. <i>Borong</i> cv. <i>Ghor</i> and naturalized material |
| 16. Burrs, 2½-4 mm high, 3-4 coils, spines 1 mm or less, inserted at 90° to coil surface, burrs glabrous at maturity (sparsely hairy when young) | ... | | <i>M. littoralis</i> cv. <i>Harbinger</i> |
| 17. Dorsal suture region wide (± 1 mm), adjacent coils not in contact, wide spaces between coils, 10-15 spines per coil, a deep groove between dorsal suture and lateral veins which is seen from the surface rather than the edge of the coil | ... | | <i>M. praecox</i> |
| 17. Dorsal suture region thin (± ½ mm), coils in loose contact, 15-20 spines per coil, groove between dorsal suture and lateral vein clearly seen on viewing coil edge-on | ... | | <i>M. polymorpha</i> var. <i>vulgaris</i> |

**Key to species based on flowering plants
without mature burrs**

- | | |
|---|--|
| 1. Flowers 10-50, peduncle more than 2x the petiole of subtending leaf | <i>M. lupulina</i> |
| 1. Flowers 1-10 (rarely — 15 in <i>M. tornata</i>) peduncle at most 2x the petiole of subtending leaf .. | 2 |
| 2. Upper surface of leaves glabrous (check on young leaves) lower surface glabrous-densely hairy .. | 3 |
| 2. Upper surface of leaves densely hairy, or with at least sparse hairs when young, lower surface moderately-densely hairy .. | 9 |
| 3. Dense glandular and non-glandular hairs on lower side of leaf and elsewhere .. | 4 |
| 3. Not as above .. | 5 |
| 4. Standard 6-7 mm long 1-2(3) flowers, upper side of stipules glabrous or with rare glandular hairs .. | <i>M. rugosa</i> |
| 4. Standard 6-7 mm long 1-3(3) flowers, upper side of stipules with dense glandular hairs .. | <i>M. scutellata</i> |
| 5. Young fruit in long spiral sideways from calyx contracting later, leaves with purple shield-shaped mark .. | <i>M. intertexta</i> |
| 5. Young fruit in contracted spiral sideways from calyx; no leaf mark, or different to the above .. | 6 |
| 6. Leaf mark an upper central blotch or a very wide shield and occupying the basal $\frac{2}{3}$ of the leaf, articulated hairs on vegetative parts | <i>M. arabica</i> |
| 6. Leaf mark none or not as above, simple hairs on vegetative parts | 7 |
| 7. Leaves oblanceolate, possibly some leaves lacinate .. | <i>M. laciniata</i> |
| 7. Leaves cuneate or obovate, margin entire or dentate .. | 8 |
| 8. Leaves 8-27 mm long, 7-19 mm wide standard 3-6 mm long, wings longer than keel .. | <i>M. polymorpha</i> |
| 8. Leaves 7-9 mm long, 5-7 mm wide, standard 2-3 mm long, wings shorter than keel .. | <i>M. praecox</i> |
| 9. Stipules entire or weakly dentate, both surfaces hairy .. | <i>M. minima</i> |
| 9. Stipules dentate or incised, upper surface glabrous .. | 10 |
| 10. Young fruit protruding sideways from calyx in long spiral, contracting later .. | <i>M. orbicularis</i> |
| 10. Young fruit contracted, usually concealed in the calyx but sometimes protruding sideways .. | 11 |
| 11. Flowers 7-10 (15), peduncle longer than petiole (up to 2x as long) .. | <i>M. tornata</i> |
| 11. Flowers 5 or less, peduncle, shorter or longer than petiole .. | 12 |
| 12. Peduncle shorter or longer than petiole, 3-5 flowers .. | <i>M. littoralis</i>
cv. Harbinger* |
| 12. Peduncle shorter than petiole, 1-2 (5) flowers .. | 13 |
| 13. Calyx lobes densely hairy, calyx teeth reaching $\frac{3}{4}$ or more the standard petal length, young pods pubescent .. | <i>M. truncatula</i> * |
| 13. Calyx lobes moderately hairy, teeth at most $\frac{2}{3}$ length of standard petal, young pods sparsely hairy .. | <i>M. littoralis</i> * |

* Mature fruits may be necessary to distinguish these species.

Species descriptions

Medicago arabica (L.) Huds., Fl. Angl. 288 (1762)

Synonymy: *M. maculata* Willd., Sp. Pl. 3: 1412 (1802).

Australian representation: The variability observed in Australia covers almost the whole species except that plants with spineless burrs, or without a purple leaf mark have not been reported.

Description: Stems, peduncles and petioles sparsely or moderately hairy, mainly *articulated hairs* on the stems and petioles, both simple and articulated hairs on the peduncles. Central leaflets usually wider than long, 10-25 mm long \times 10-28 mm wide, cuneate or obcordate, upper leaves more obovate, apex retuse or emarginate, upper surface glabrous *with an upper-central purple mark* ranging from a small dot to a large inverted V, or a wide basal shield occupying the basal $\frac{2}{3}$ of the leaf, no other purple flecks but sometimes small white flecks (the purple blotch may fade in herbarium specimens), lower surface sparsely or densely hairy,

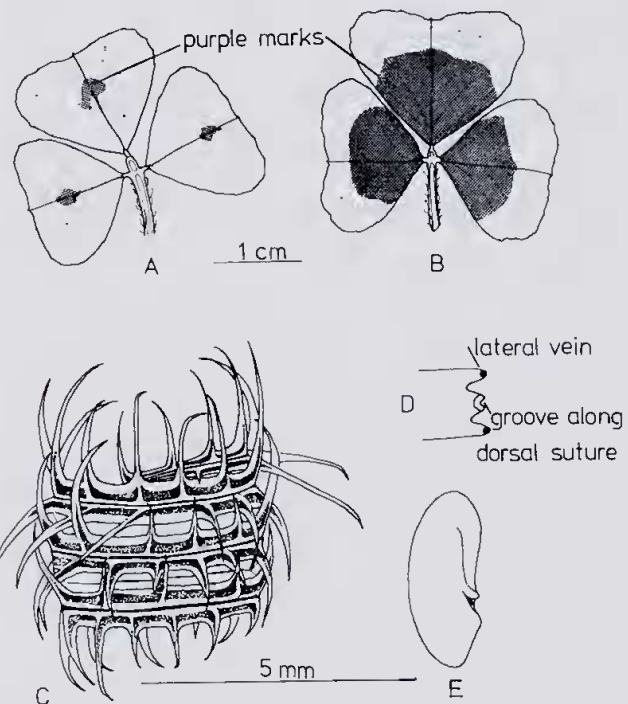


Figure 4.—*Medicago arabica*. A and B: leaf types. C: burr. D: diagrammatic T.S. of coil edge showing relative position of veins and grooves. E: seed.

simple hairs on the lamina and a few articulated ones on the mid rib. Seedling leaves sometimes digitate, older leaves clearly pinnate. In more luxuriant specimens the number of leaflets may occasionally be 4 or 5. Petioles may be very long (up to 15 cm). Stipules with small sharp teeth, sparse or dense articulated hairs on lower side only. Peduncles much shorter than the subtending petioles (peduncles may be only $\frac{1}{3}$ or $\frac{1}{5}$ of the petiole) with a slender awn \pm 3 mm long with simple and articulated hairs. Flowers 2-4(5) per raceme, calyx with moderately dense simple hairs, teeth equal to tube; standard 4-5 mm long, keel \pm 1 mm longer than

the wings. Developing pod contracted and protruding sideways from the calyx, coiling anticlockwise. Mature fruits 1-4 per raceme, barrel-shaped, top coils markedly concave, basal coils less so, 4-6 soft coils not firmly appressed, (4) 5-7 mm diameter, 5-7 mm high, with soft intermeshed spines up to 4 mm long which have a clear basal groove, inserted at 90-120° to the coil surface, tips straight or slightly hooked, pod surface glabrous. Few radial veins, veins distinct in the centre but anastomosed into a fine net towards the outer edge of the coil, lateral veins in the same plane or protruding slightly beyond the dorsal suture, a deep groove between each lateral vein and the dorsal suture and a shallow one bisecting the dorsal suture. (A coil viewed from the edge has 4 ridges and 3 grooves). Seeds, 5-8, separated by thin membranes, subreniform, yellow to light brown, 2½-3 mm long, ± 1½ mm wide, radicle longer than half the length of the cotyledons, extreme tip of radicle may protrude vertically, hilum small. 2n = 16.

Common name: "Spotted medic" or "spotted burr medic". These names refer to the prominent leaf blotch, and the resemblance of this species to burr medic, *M. polymorpha*.

Cultivars: None.

Distribution: Naturalized but uncommon on fertile soils in the lower south west of Western Australia and around Perth.

Medicago intertexta (L.) Mill., Gard. Dict. ed. 8, No. 4 (1768)

Synonymy: *M. ciliaris* Willd., Sp. Pl. 3:1411 (1802) p.p.

M. ciliaris All., Fl. Pedem. 1:315 (1785).

M. echinus DC., Fl. Fr. 4:546 (1805).

Australian representation: The description is of naturalized material of *M. intertexta* var. *intertexta*. All naturalized material appears to have the basal leaf mark but this is not a varietal characteristic. Black (1957) records *M. ciliaris* Willd. (= *M. intertexta* var. *ciliaris* (L.) Heyn), from South Australia but I have been unable to confirm the occurrence of this variety other than in collections of imported material at agricultural research stations (Hj. Eichler, pers. comm.). Variety *decandollei* is endemic to Sicily and not naturalized in Australia. The validity of Heyn's (1963) taxonomic treatment might be questioned as in crosses between var. *intertexta* and var. *ciliaris* Lesins *et al.* (1968) showed that leaf markings and pod hairs were probably under the control of single genes but hybrid fertility was only 40%. Lesins considers the two taxa to be separate species.

Description: Stems and petioles glabrous, peduncles with sparse simple hairs. Central leaflets 15-20 mm long x 8-15 mm wide, obovate or oblanceolate, apex apiculate, edge serrate almost to base, upper surface glabrous, lower surface sparsely hairy. Upper surface with a purple, basal shield-shaped mark, no other leaf flecks. This mark may fade in older plants and is not always retained in herbarium material. Stipules deeply dentate, sparse hairs on lower side or confined to margin. Peduncle variable length,

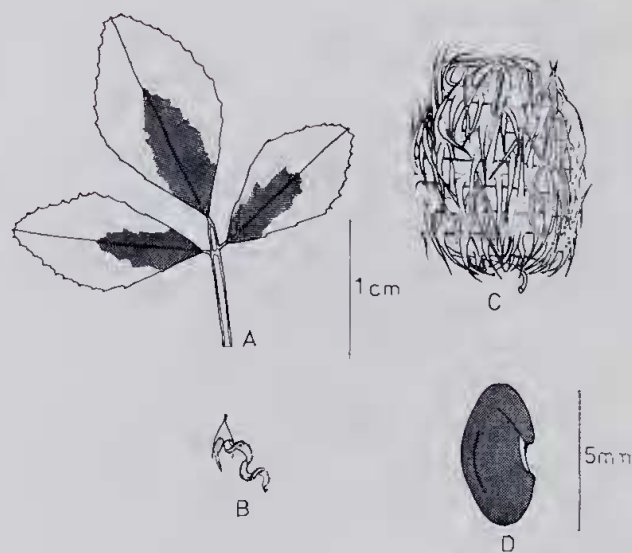


Figure 5.—*Medicago intertexta* var. *intertexta*. A: leaf. B: young developing burr. C: burr. D: seed.

often longer than subtending petiole in flower, equal in fruit, awn from very short to 5 mm, glabrous, often easily detached. Flowers 3-7 calyx with a few hairs at base of teeth, teeth equal to tube or longer. Standard 7-10 mm, keel and wings almost equal or wings longer. Developing pod initially not contracted but protruding sideways from the calyx in a long spiral coiling anticlockwise. Mature fruits 1-2 per raceme, spherical to ovoid, 10-14 mm diameter, 11-16 mm high, 8-11 coils loosely appressed, glabrous, with long intermeshed spines up to 6 mm long inserted at 90°-100° to surface of coil, tips not hooked, clear basal groove. No lateral veins, radial veins anastomosed into a net and one vein running from this net into the base of each spine. The dorsal suture has a central groove. Seeds 5-11, no partitions between the seeds, subreniform black, 3-5½ mm long x 2-3 mm broad, radicle less than ½ the length of the cotyledons, tip clear but not protruding, hilum and strophiole region brown. 2n = 16.

Common name: "Calvary medic"—relating to the old myth that the blood red leaf marks resulted from blood from the crucifixion; hedgehog medic—relating to the very spiny burrs.

Cultivars: None.

Distribution: Only two specimens have been collected from Western Australia: from Busselton (1928) and Brunswick (1916). As there are no recent collections, it is doubtful if the species has persisted.

Medicago laciniata (L.) Mill., Gard. Dict. ed. 8, No. 5 (1768)

Australian representation: Varieties *laciniata* and *brachyacantha* Boiss. both occur in Australia.

Description: Stems, petioles and peduncles with sparse simple hairs, central leaflets 8-11 mm long x 4-6 mm wide, oblanceolate, apex truncate, retuse and apiculate or tridentate, leaf margins serrate or irregularly lacinate, upper surface glabrous, lower surface with sparse or

dense simple hairs. Leaves may show purple and white flecking. Stipules deeply incised or lacinate, simple hairs on lower side only. Peduncle longer or shorter than subtending petiole, extended into an awn 1-3 mm long glabrous or with a few hairs. Flowers 1-2(3), calyx sparse to moderately hairy, teeth shorter than the tube. Standard $4\frac{1}{2}$ -6 mm long, keel slightly longer than the wings. Developing pod contracted but protruding sideways from the calyx coiling anticlockwise. Mature fruits 1(2) per raceme, olive-shaped, globular or cylindrical, 5-6 mm diameter, 5-7 mm high, burrs soft at maturity, 5-8 coils not strongly appressed, spines $2-4\frac{1}{2}$ mm long,* inserted at 90° - 180° to surface of coils, tips hooked, distinct basal groove, pod surface glabrous or with a few simple hairs.

Varieties:

1. Burrs with a 5-8 coils olive-shaped or globular, peduncle longer than petiole, stipules lacinate, at least some leaves lacinate—var. *laciniata*
1. Burrs with 3-4½ coils cylindrical, peduncle shorter than petiole, stipules incised, leaves dentate—var. *brachyacantha* Boiss.

Common name: "Cut-leaf medic" which refers to the dissected appearance of some of the leaves of var. *laciniata*. The name is also loosely applied to var. *brachyacantha* which does not have lacinate leaves.

Cultivars: None.

Distribution: Of limited occurrence in the lower rainfall areas usually in the same region as *M. minima*; north-eastern fringe of the cereal-growing areas of W.A. and east of Kalgoorlie. Variety *brachyacantha* appears the less common. In Israel var. *brachyacantha* occurs in more extreme desert habitats than var. *laciniata* (Friedman in Heyn 1971).

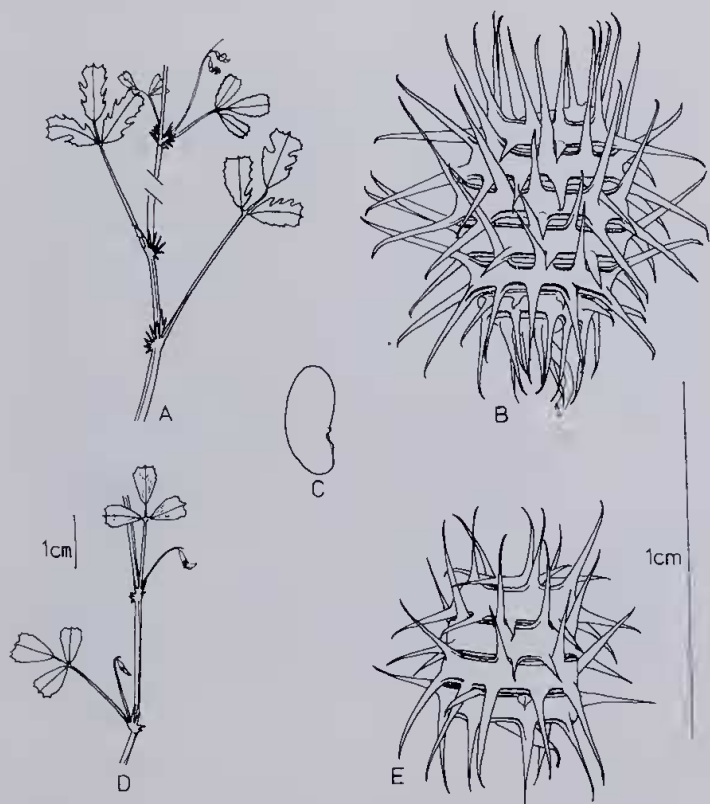


Figure 6.—*Medicago laciniata*. A-C: var. *laciniata*. A: vegetative morphology. B: burr. C: seed. D-E: var. *brachyacantha*. D: vegetative morphology. E: burr.

Radial veins S-shaped and not anastomosed until they enter lateral veins which are separated from the strongly developed dorsal suture by a deep groove. Dorsal suture region glabrous and in fresh material often glaucous. Seeds (7)9-12(14) not separated by partitions, oval-slightly reniform yellow to brownish yellow, 2-3 mm long, 1-1.5 mm wide, radicle longer than half the cotyledons, radicle tip clear but very rarely curled out, hilum a small hollow. $2n = 16$.

* Considerable variation in spine development may be observed in burrs on the same branch (e.g., specimens from Parkeston railway sheds, PERTH.). It is not certain that this is natural variation, as Mr. A. C. Linto of the W.A. Agriculture Department has suggested that it may be due to treatment of railway reserves with hormonal weedicides.

Medicago littoralis Rohde³ ex Lois-Delong., Not. F1. France: 118 (1810)

Australian representation: Naturalised *M. littoralis* is rare in Western Australia and only the var. *littoralis* has been recorded. *M. littoralis* cv. Harbinger is described separately as it is unlike the typical naturalised *M. littoralis*.

Description: Stems, petioles and pedicels with moderate-dense simple hairs. Central leaflets 7-14 mm long x 7-11 mm broad, cuneate or obovate, apex truncate retuse or obtuse, apiculate, margin serrate along upper $\frac{1}{3}$, upper surface sparse-densely hairy, lower surface densely hairy, purple flecks on upper side, sometimes concentrated along the mid rib. Stipules deeply incised with sparse hairs on lower side. Peduncle usually shorter than subtending petiole in flower and fruit, with a hairy awn up to 5 mm long. Flowers 1-3, calyx moderately hairy, teeth longer than tube (atypical for *littoralis*). Standard 5-7 mm long, keel longer than the wings. Developing pod contracted concealed in calyx or protruding sideways, coiling anticlockwise. Mature fruit 1-2 per raceme, cylindrical, 4-5 coils strongly appressed, hard at maturity, 5-6 mm diameter, 5-7 mm high, few hairs on young pods, glabrous at maturity. Venation difficult to see, about 10 radial veins on the coil surface, anastomosing and entering a lateral vein separated from the dorsal suture but in the same plane on the edge of the coil, region between dorsal suture and lateral vein flat, spines long (up to 4 mm) hooked at tips, no basal groove, inserted at 130° in middle to 90° on end coils. Seeds 6-8(9), separated by partitions, subreniform or reniform, yellowish, $2\frac{1}{2}$ -4 mm long x $1\frac{1}{2}$ -2 mm wide, radicle less or just equal to half the length of the cotyledons, tip clear, rarely slightly protruding, hilum, obscure. $2n = 16$.

* The description of this species was sent to Loiseleur-Deslongchamps by MM. Rohde, Bertoloni, Suffren and Requier. In later works the species name is frequently spelled incorrectly *littoralis* and the authority given as Rhode.

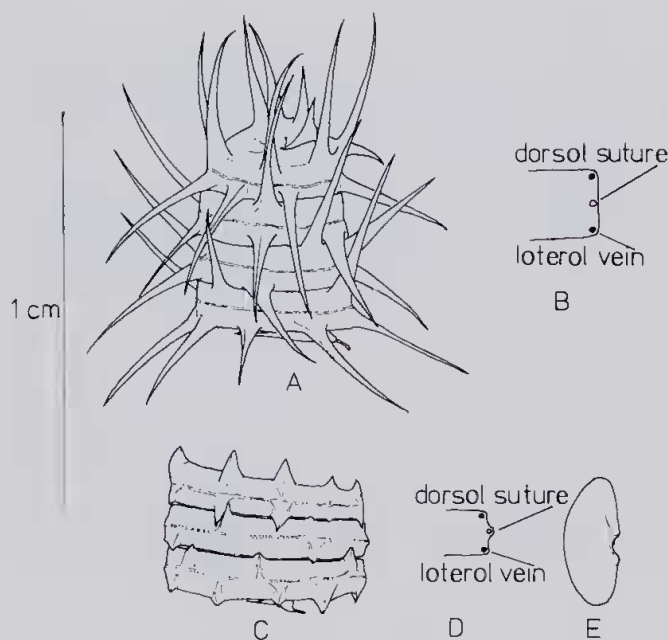


Figure 7.—*Medicago littoralis*. A-B: var. *littoralis*. A: burr. B: diagrammatic T.S. of coil edge. C-E: cv. Harbinger. C: burr. D: diagrammatic T.S. of coil edge. E: seed.

Common name: 'Strand medic' selected by the Victorian Herbage Liaison Committee to describe the coastal distribution of this species in its native Mediterranean habitat.

Cultivars: cv. Harbinger.

Distribution: There are two records of *M. littoralis*. One is a roadside population which has been known for several years, 10 km south of Geraldton on Mr. E. K. Doncon's property. It was collected by Mr. G. L. Throssell in 1958 and incorporated into the W.A. University *Medicago* collection as No. 2500. This accession has been used in crosses between *M. littoralis* and *M. truncatula*, and *M. tornata* (Simon 1965; Simon and Millington 1965).

The second record is a PERTH specimen "Merredin test rows—seed from J. Suiter, Moorine Rock". In view of the preference of *M. littoralis* for coastal habitats the Moorine Rock specimen seems unlikely to be from a naturalized population.

Cultivar Harbinger. 'Harbinger' has been registered as a cultivar of *M. littoralis*. *M. littoralis* is known to hybridize with both *M. truncatula* and *M. tornata* in the field (Heyn 1963) and artificially (Simon 1965; Simon and Millington 1965), and cv. Harbinger appears to have had a hybrid origin. Vegetative features such as the lengths of the branches, and shape of leaflets in cv. Harbinger relate to *M. truncatula* or *M. tornata* rather than *M. littoralis* while the size of the leaflets, the number of flowers, and perhaps the peduncle: petiole ratio indicate some introgression to *M. tornata*. The position of the lateral veins on the surface rather than the extreme edge of the coils, the presence of indentations between spine bases and the insertion of the spines at 90° rather than 130° are *M. truncatula* characteristics. The only features of *M. littoralis* are the calyx teeth which are

broad at the base and about equal to the tube in length, and the pollen which is spindle-cylinder shaped when dry and shows 3 pores when stained, as is typical for *M. littoralis* (Lesins and Lesins 1963). *M. truncatula* pollen is triangular to pyramidal or bisphenoid when dry and shows 4, (rarely 5 or 6) pores when stained. I have observed that *M. tornata*, a species not included in the Lesins' survey, has the same pollen morphology as *M. littoralis*.

The origin of cv. Harbinger is confused and it is suggested that it may have originated from Iran in 1940 (Barnard 1972). However, Heyn (1963) states that *M. truncatula*, *M. littoralis* and *M. tornata* do not occur in Iran. If the argument for a hybrid origin is accepted, then the source locality for cv. Harbinger must be a region where two or all three of the species grow and may hybridize.

Description: as for *M. littoralis* with the following points of difference:

Central leaflets (11) 16-19 mm long x 8-11 broad, cuneate only in the rosette stage, obovate or oblanceolate, apex obtuse and apiculate, margin serrate in upper half, rare purple flecks on the upper side. Peduncle equal or longer than subtending petiole in flower, equal or shorter in fruit. Flowers 3-5, calyx teeth equal or shorter than tube. Mature fruits (2) 4-5 per raceme, 3-4 coils, 4-5 mm diameter x 2½-3½ mm high. Lateral veins on the surface of the coil rather than the extreme edge, separated from the dorsal suture by a groove in young and mature pods, except in the most fleshy thickened burrs. Spines short and straight or tubercles, variable in length on the same pod or between pods on the same plant. Seeds 3-4 (5), 3-3½ mm long x 1¼-1¾ broad.

Distribution: The cultivar does best on deep yellow sands in the northern cereal areas and is occasionally naturalised along roadsides in the Geraldton district. It is also grown near Salmon Gums.

Medicago lupulina L., Sp. Pl. 2:779 (1753)

Australian representation: The naturalized Western Australian material behaves as an annual (Quinlivan (1965) but Barnard (1969) reports that in other states plants may be biennial or perennial. The species is commonly included in *Medicago*, and crosses between *M. sativa* and *M. lupulina* are possible when *M. sativa* is used as the female parent (Southworth 1914; Schröck 1943). *M. lupulina* has non-articulated cotyledons, a generic characteristic of *Medicago*, but it is very like *Melilotus* in its vegetative parts, inflorescence and nutlet-like pod. Further, some forms lack the typical *Medicago* floral tripping mechanism (Heyn 1963) and it has been mentioned above that the thickening of the anther sheath and swelling of the bases of alternate anthers may be reduced or absent. Thus some forms of *lupulina* do not possess all the characteristics necessary for inclusion in *Medicago* and Simon (1969) as shown serological differences between *M. lupulina* and *M. secundiflora* (Section *Lupularia*) and the remaining species of *Medicago*.

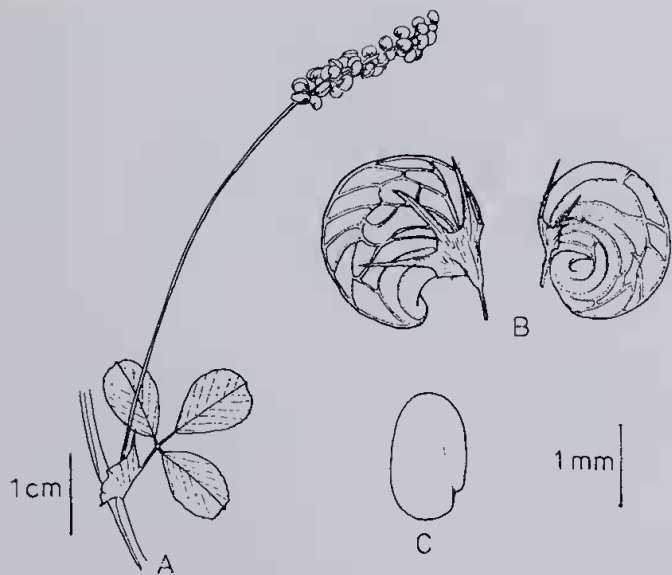


Figure 8.—*Medicago lupulina*. A: leaves and fruits. B: fruits (hairs on leaves and fruits not shown). C: seed.

Description: Stems, petioles and peduncles densely covered with simple hairs. Central leaflets from leaves in rosette $4\frac{1}{2}$ - $6\frac{1}{2}$ mm long x $4\frac{1}{2}$ -7 mm broad, orbicular, cuneate or obovate, sometimes appearing digitate, with petioles up to 7 cm long; leaves on branches 11-15 mm long x 6-10 mm broad, obovate-oval, apex retuse or apiculate, upper half of margin serrate, clearly pinnate, and petioles rarely more than 1 cm long upper surface virtually glabrous to densely hairy, lower surface always densely hairy. No leaf flecks or marks. Stipules entire or dentate, upper surface usually glabrous (rarely a few hairs), lower surface densely hairy. Peduncles longer than subtending petioles in flower, elongating in fruit to reach 3-5 times the petiole, awn lacking or small ($1-1\frac{1}{2}$ mm long and difficult to see), floral bracts \pm equal to pedicel. **Flowers** (10) 20-50 in dense oblong heads 10 mm or more long. Calyx moderately hairy the 3 anterior teeth slightly longer, and the 2 posterior teeth shorter than the tube. **Standard** $2-2\frac{1}{2}$ mm long, sometimes only just longer than the calyx teeth, wings slightly longer than the keel. **Pod** a single-seeded nut with only the distal end coiled. Mature fruits 10-40 per raceme, reniform with convex sides, or discoid, $2-3\frac{1}{2}$ mm long x 1-2 mm wide, spineless, glabrous or hairy with appressed or erect, simple, or simple and glandular hairs. Pod often blackening when ripe, prominent radial veins in almost concentric semicircles, anastomosing and running into the dorsal suture. Single seeds, round or oval, yellow or yellow-brown, $1\frac{1}{2}$ - $2\frac{1}{2}$ mm long x $\frac{3}{4}$ - $1\frac{3}{4}$ mm wide, radicle longer than half the length of the cotyledons, tip distinct and rarely slightly protruding. $2n = 16, 32$: it is not known whether both types occur in Australia. **Common names:** 'Black medic' which relates to the black fruits of the species.

Cultivars: None, but it is interesting to note that this species was the first medic offered for sale in Western Australia in colonial times (Quinlivan *et al.* 1974).

Distribution: Rare in Western Australia. Herbarium specimens from Elleker (W. of Albany), Denmark, Yarloop and Nungarin do not distinguish between plants deliberately cultivated and naturalized occurrences. It is a late maturing species and in other Australian states is naturalized in the cooler districts to specimens from the first 3 localities are possibly from naturalized stands but it is unlikely that the species is naturalised at Nungarin. It is known to have been established around Deeside at Lake Muir but it does not appear to have persisted (Quinlivan, pers. comm.).

Medicago minima (L.) Bart., Cat. Plant. Siena: 61 (1776)

Synonymy: *M. minima* (L.) Grufbg., Fl. Angl.: 21 (1754).

Australian representation: Most of the range of variability for the species is seen in Australian material. However, the maximum number of flowers appears to be 5, (in var. *brevispina*), while in Mediterranean material up to 8 flowers have been recorded.

Description: Stems, petioles and peduncles densely covered with simple hairs, or, especially in some var. *brevispina*, simple and glandular hairs. Central leaflets 5-14 mm long, $3\frac{1}{2}$ -7 mm broad, leaflets from the rosette may be orbicular, cuneate or obovate, on branches they are obovate or oblanceolate, apex retuse, mucronate or tridentate, upper $\frac{1}{3}$ of margin serrate, upper and lower surfaces densely hairy with simple, or simple and glandular hairs. Upper surface of leaf lamina may be without flecks or marks or have a dense line of purple flecks along the mid

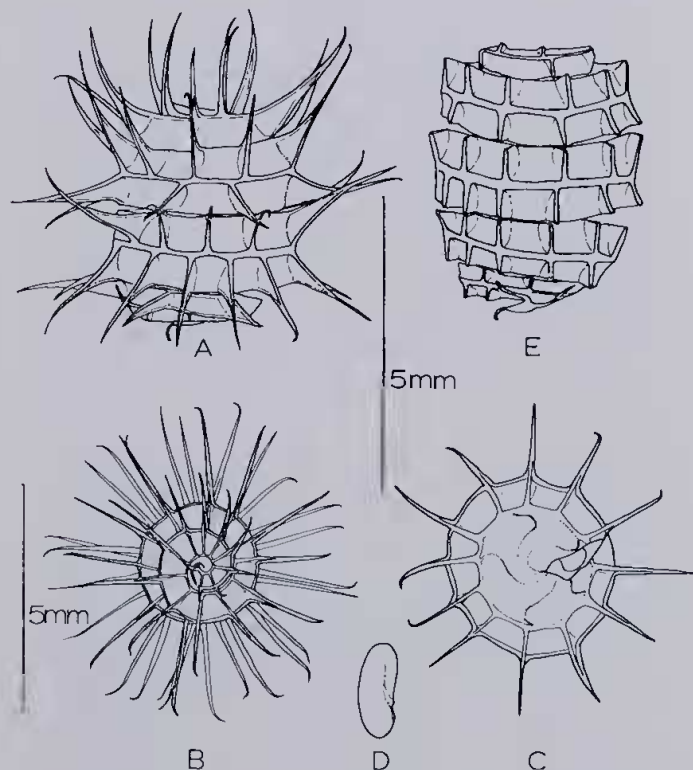


Figure 9.—*Medicago minima*. A-D: var. *minima*. A and B: burr types. C: venation on coil surface. D: seed. E: var. *brevispina* burr. (hairs on burrs not shown).

rib. In the rosette, petioles may reach $4\frac{1}{2}$ cm but on the branches they are usually only 1 cm long. *Stipules entire or with small teeth*, hairy on both sides. The pubescence on the vegetative parts may give the plant a *greyish tomentose* appearance. Peduncles shorter or longer than the subtending petiole, extended into a short hairy awn (1-2 mm long) which may be difficult to see. Flowers 1-2 (-5 in var. *brevispina*), calyx densely hairy teeth longer than the tube the 3 anterior teeth being slightly longer than the 2 posterior ones. Standard $3\frac{1}{2}$ -5 mm long, wings and keel of equal length or keel slightly longer. Developing pod contracted, protruding sideways from the calyx, coiling anticlockwise. Mature fruits 1-2 (-5 in var. *brevispina*) per raceme, discoid, olive-shaped or barrel-shaped. $3\frac{1}{2}$ -5 soft thin walled coils not firmly appressed, 3-5 mm diameter, $2\frac{1}{2}$ -5 mm high, glabrous or with simple, or simple and glandular hairs, spineless, tuberculate or with long hooked spines (up to $3\frac{1}{2}$ mm), inserted at 180° to coil surface in centre coils, and about 120° in apical coils, long clear basal groove. Radial veins few (6-8) strongly bent to S-shaped, not anastomosing, joining a marked *lateral vein which is separated from the dorsal suture by a slightly concave margin about $\frac{1}{3}$ the radius of the coil*, across which run only the veins to the spines. Dorsal suture marked but not as wide as in *M. laciniata* or *M. praecox*. Seeds (3) 4-6 (7) per burr, *not separated by membranes**, oval-subreniform, yellow or yellow-brown $1\frac{1}{2}$ - $2\frac{1}{2}$ mm long, $\frac{3}{4}$ - $1\frac{1}{4}$ mm wide, radicle slightly longer than half the cotyledons, tip may protrude slightly, hilum obscure. $2n = 16$.

Varieties (from Heyn, 1963):

1. Burr discoid or ovate, spines hooked, longer than $\frac{1}{2}$ the radius of the coils—var. *minima*
1. Burr olive—or barrel-shaped, spines lacking, tubercles or short straight spines less than $\frac{1}{2}$ the coil radius—var. *brevispina* Benth.

The drawing of var. *brevispina* (Fig. 9E) is of a line similar to that sometimes referred to as *M. sesilis* Peyr. Burrs with no trace of spines and the coil edges completely smooth are also known.

Common name: 'Woolly burr medic', derived from the superficial resemblance of the burr to burr medic (*M. polymorpha*), and the woolly pubescence of the plants. "Goldfields medic" due to its distribution in Western Australia, or rarely and incorrectly, "Kalgoorlie Clover". 'Little medic' is the common name in Victoria (Willis 1972).

Cultivars: None.

Distribution: Widespread but of isolated occurrence in drier parts of the wheat belt extending into semi-arid sheep country. As far N. as Port Gregory, E. to Norseman and S. to Ravensthorpe, most common in the Merredin and Kalgoorlie districts. The spineless var. *brevispina* has been collected from near Merredin (Quinlivan and Francis, pers. comm.). Spread of the species has sometimes been assisted by farmers in the eastern wheatbelt by raking up burrs and distributing them on their properties.

* Heyn (1963) states that there are thin interseminal membranes but these were not seen in Australian material.

Medicago orbicularis (L.) Bart., Cat. Plant.
Siena : 61 (1776)

Australian representation: The Australian material appears to be from the types with large burr sizes. The species is particularly variable and many attempts have been made to create intraspecific taxa. Heyn (1963) does not recognize any varieties as she considers that all characters used in previous subdivisions were not sufficiently discontinuous.

Description: Stems, petioles and peduncles with sparse to moderately dense simple hairs, or simple and glandular hairs. Central leaflets 11-17 mm long \times 9-13 mm broad, cuneate or obovate, apex retuse or apiculate, marginal serration extending almost to base, upper surface glabrous, lower surface sparsely hairy. Stipules deeply incised or lacinate, glabrous or a few hairs on the lower side, mainly along the margins. Peduncle usually shorter than the subtending petiole in flower, sometimes equal in fruit, produced to a long awn (up to $6\frac{1}{2}$ mm) with a few hairs. Flowers 1-2 (5), calyx moderately hairy with teeth longer than the tube, standard 4-6 mm long, keel \pm 1 mm longer than the wings, *developing pod initially not contracted but protruding sideways from the calyx as a long spiral*, coiling anticlockwise. Mature fruits 1 (2) per raceme, pod shape (W.A. material) lenticular widest coil in the middle 13-17 mm wide, $3\frac{1}{2}$ -7 high, spineless, glabrous. Simple or simple and glandular hairs (often early deciduous), 4-7 soft coils not firmly appressed, *with a wide thin border often undulating*. Straw coloured or blackening to different degrees. *No lateral veins*, radial veins anastomosed into a net and running to dorsal suture, sometimes thick and raised towards the dorsal suture coil margin. Seeds (10) 15-20 (26) separated by short partitions

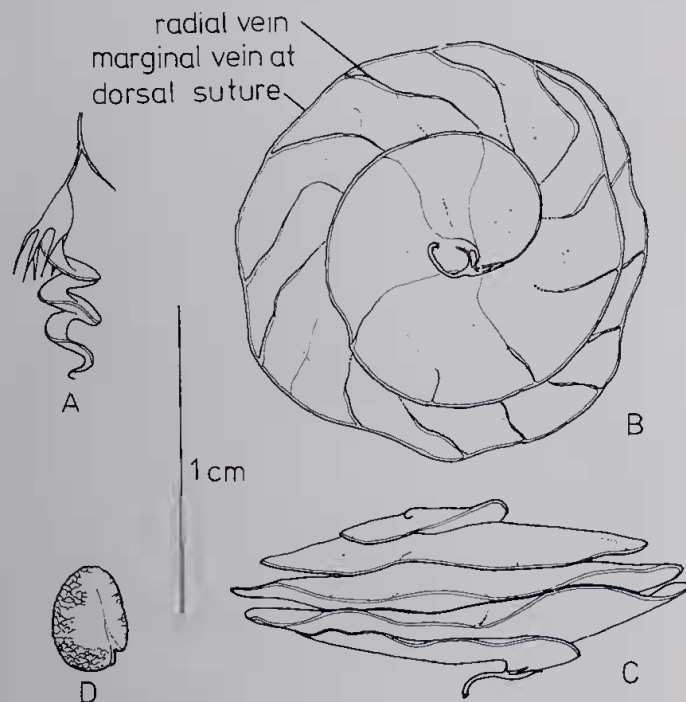


Figure 10.—*Medicago orbicularis*. A: developing fruit. B: ventral surface and C: side view of fruit (hairs not shown). D: seed.

which do not extend out to the edge of the coil, orientated so that the *radicle is vertical to the axis* (rather than tangential as in other Australian species), *surface rough or minutely tuberculate* (all other Australian species are smooth), yellowish-brown triangular in shape, *the radicle being almost as long as the cotyledons*, tip clear but not protruding, 3-3½ mm long x 1½-3 mm broad, hilum small. 2n = 16.

Common name: "Button Medic"—derived from the pod shape.

Cultivars: Nene.

Distribution: A single herbarium specimen from Southern Cross, collected in 1925. It seems unlikely that the species would naturalise in this area as records from other states indicate that it requires a long growing season and is late maturing (Barnard 1969).

Medicago polymorpha L., Sp. Pl. 2:779 (1753)

Synonymy: *M. hispida* Gaertn., De Fruct. 2:349 (1791).

M. lappacea Desr., in Lam. Encycl. Method. 3:637 (1772) p.p.

M. apiculata Willd., Sp. Pl. 3:1414 (1802) p.p.

M. denticulata Willd., Sp. Pl. 3:1414 (1802) p.p.

M. terebellum Willd., Sp. Pl. 3:1416 (1802) p.p.

M. reticulata Benth., Cat. Pyr. 101 (1826) p.p.

M. confinis Koch., Syn. Fl. Germ. ed I. 164 (1837) p.p.

Australian representation: The species is a widespread weed and occasional pasture component and examples are found of all the three varieties described by Heyn (1963): var. *polymorpha*, var. *vulgaris* (Benth.) Shin., var. *brevispina* (Benth.) Heyn. The separation of these varieties is unsatisfactory as there is an abundance of material intermediate between all varieties.

Description: Stems, petioles and peduncles virtually glabrous or sparse hairs on young petioles and peduncles. Central leaflets 8-20 (27)mm long x 7-15(19)mm wide, cuneate to obovate, apex obtuse or retuse, apex apiculate, margin almost entire or with upper ½ serrate, upper surface glabrous, lower surface glabrous or with sparse hairs. Leaves sometimes with purple and/or white flecks, and/or a basal purple mark which may be either a solid or an empty inverted V. Stipules deeply incised to lacinate, glabrous or a few hairs concentrated along the margin. Peduncle usually shorter, or sometimes longer, than subtending petiole, awn lacking or up to 3 mm long. Flowers (1)2-7 (8), calyx with few hairs, teeth longer than the tube. Standard 3-5 mm long, *wings longer than keel*. Developing pod initially contracted and protruding sideways from the calyx, coiling anticlockwise. Mature fruits 1-5 per raceme, discoid, cylindrical, or truncated cone, 4½-8½ mm wide x 2-10 mm high, without spines or with short or long spines (up to 3½ mm), the longer ones usually hooked and with a short groove at the base, inserted at 180° to pod surface on middle coils sometimes 90° on apical coils, 1½-6½ coils, soft or hard at maturity, not strongly appressed, surface glabrous or sparsely hairy. *Many (15-20 per coil) radial veins strongly curved, anastomosing into a net and joining a lateral vein which is separated from the wide*

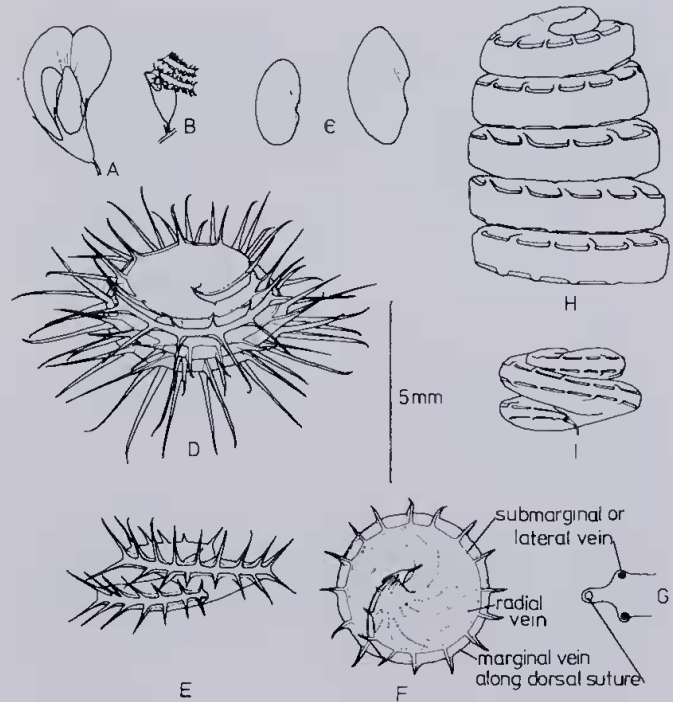


Figure 11.—*Medicago polymorpha*. A: flower. B: developing burr. C: seeds. D: var. *polymorpha* burr. E: var. *vulgaris* burr. F: venation on ventral coil. G: diagrammatic T.S. of coil edge. H and I: var. *brevispina* burr types.

dorsal suture by a narrow groove. Seeds (3) 4-8(11) per burr, separated by partitions, oval to subreniform, yellow-yellow brown, 2½-4 mm long x 1¼-2½ mm broad, radicle equal or less than half the length of the cotyledons, tip not at all protruding. 2n = 14.

Varieties (from Heyn 1963 and 1970):

var. *polymorpha*: Spines of fruit thick and hardened, coils 4-6, hardening at maturity, diameter of broadest coil 5-8 (10) mm (coils sometimes 3½, the diameter exceeding 6 mm); inflorescence usually few flowered, (1) 2-5 flowers).
var. *vulgaris* (Benth.) Shin. in Rhodora 58:310 (1956) emend. Heyn, Scripta Hierosolymitana 12:75 (1963). Spines of fruit slender, coils 1½-3½ usually soft, even at maturity, diameter of broadest coil (2) 3-5 (6) mm, inflorescence usually many flowered (5-10 flowers).

var. *brevispina* (Benth.) Heyn, Scripta Hierosolymitana 12:77 (1963). Spines lacking, margin of coils smooth or tubercled, coils (2)3-5 often hardening at maturity, diameter of broadest coil (2½) 3-4 (5½) mm, inflorescence (1) 2-10 flowers.

In Western Australian material there appears to be spineless forms of var. *vulgaris* with up to 5 fruits per raceme and small burrs (4-6 mm diameter x 2-3 mm high with 2-2½ coils), and spineless forms of var. *polymorpha* which have 1-2 fruits per raceme and larger burrs (4-6 mm diameter x 4-6 mm wide with 3½-4(5) coils). All the spineless material is classified as var. *brevispina*.

Common names: "Burr medic" which relates to the spiny pods, or, more rarely, "toothed medic", which is derived from one of the synonyms, *M. denticulata*, and refers to the very small teeth usual on the leaf margins.

Distribution: The spiny varieties of the species are established in most of the agricultural and pastoral areas, extend into the Goldfields, and may be found as adventitious weeds in suitable wet places such as wells and tanks, along roads and railway lines as far north as Carnarvon and east to Forrest. The spineless form is rare but is distributed throughout the most of the range of the spiny varieties.

Medicago praecox DC., Adnot. Cat. Hort.
Monsp. :123 (1813)

Australian representation: The description for Australian material encompasses the whole species. There are no varieties described for this species and it shows less variation than some other *Medicago* species.

Description: Stems, petioles and peduncles with sparse to moderately dense simple hairs. Central leaflets 5.5-9 mm long, 5-9 mm broad, obcordate, or obovate, apex apiculate, upper 1/3 of margin serrate, upper surface glabrous, lower surface densely hairy, no purple flecks or leaf marks.

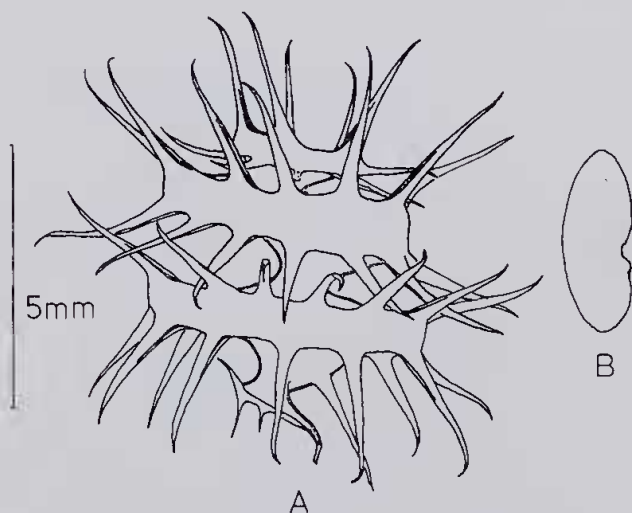


Figure 12.—*Medicago praecox*. A: burr. B: seed.

Stipules deeply incised, with a few simple hairs on the lower side only. Peduncles much shorter than the subtending petiole in both flower and fruit, no awn, or rarely a very short one (± 0.5 mm). Flowers 1-2, calyx with moderately dense simple hairs, teeth \pm equal to tube but front 3 teeth slightly longer than back 2. Standard 2-3 mm, keel ± 1 mm longer than wings. Developing pod contracted and protruding sideways from the calyx, coiling anticlockwise. Mature fruits 1 (2) per raceme, coils *not appressed*, shape (without the spines) a cylinder or truncated cone, 4-5 mm diameter, 4-5½ mm high, spines 2-3 mm long, hooked at tips, strongly grooved at the base, inserted at 90°-120° to coil surface, frequently in opposite pairs from the wide dorsal suture, coil surface with sparse hairs, suture region glabrescent. Radial veins 8-12 per coil, strongly curved, anastomosing, entering a distinct lateral vein which is separated from the wide dorsal suture by a *narrow deep groove which is visible from the coil surface rather than from the side of burr*. Seeds (3)4-6,

separated by partitions, oval to subreniform, yellowish, 2-3 mm long \times 1-1½ mm broad, radicle slightly less than half the length of the cotyledons, with tip closely appressed, hilum obscure. $2n = 16$.

Common name: "Small leaf burr medic" as this species is sometimes mistaken for a small-leaved form of burr medic (*M. polymorpha*).

Cultivars: None.

Distribution: The species was previously thought to be absent from Western Australia, but I have found it at 3 widespread localities so it is unlikely to be a recent introduction. (On red soils N. of Mingenew, 20 km N. of Merredin, and E. of Gnowangerup.) Heyn (1963) notes that it is rare, even in the Mediterranean.

Medicago rugosa Desr., in Lam. Encycl.
Method. 3:632 (1792)

Australian representation: The only representative of this species in Australia is the cultivar Paragosa, so this description covers only the variability observed in the cultivar.

Description: Stems, petioles and peduncles densely covered with simple and glandular hairs. Central leaflets 10-23 mm long \times 7-15 mm broad, obovate or oblanceolate, apex obtuse or slightly retuse, upper half of leaf margin serrate, upper surface with rare purple flecks or none, glabrous, lower surface with dense glandular and simple hairs, stipules with small sharp teeth, dense glandular and simple hairs on lower side, very rare glandular hairs on upper side. Peduncle shorter than the petiole of the subtending leaf, sometimes becoming equal when fruiting, peduncle with a hairy awn 4-5 mm long. *Flowers* (1) 3-5 *nearly all inserted on the same side of the peduncle*. Calyx with dense glandular and simple hairs, teeth shorter or equal to the tube. Standard 3-4 mm long, keel slightly longer than the wings. Developing pod contracted but protruding sideways from the calyx, anticlockwise coiling. Mature fruits 1-3 per raceme, 3½-5 concave coils, strongly appressed, 6-9 mm diameter, 3-4½ mm high, spinless, *pod disc- or lozenge-shaped, surface with glandular and simple hairs* which may rub off exposed parts of dry burrs. *No lateral veins*, very marked radial veins arising in opposite or alternate pairs from the thick dorsal suture, no anastomosis in the outer ½ of the pod diameter. Seeds 1-2 (rarely more), *not separated by partitions*, strongly

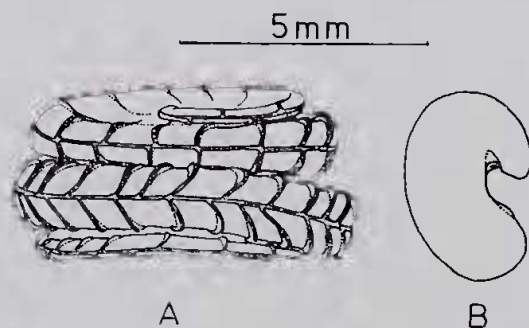


Figure 13.—*Medicago rugosa* cv. Paragosa. A: burr (hairs not shown). B: seed.

reniform, glossy, bright- to dark- or brownish-yellow, 3-4½ mm long, 2-3 mm broad, radicle less than half the length of the cotyledons with a strongly protruding tip, hilum very small and obscure. 2n = 32.

Common name: 'Gama medic' given to this species by the South Australian Herbage Plant Liaison Committee, as the accession from which the cultivar was selected, (CPI 7791), was originally collected in Portugal, the homeland of Vasco da Gama the navigator.

Cultivar: One cultivar, cv. Paragosa.

Distribution: The cultivar grows best on heavy alkaline soils, and is rarely grown and not naturalized in Western Australia.

Medicago scutellata (L.) Mill., Gard. Dict. ed. 8: No. 2 (1768)

Synonymy: *M. scutellata* (L.) All., Fl. Pedem. 1: 315 (1785).

Australian representation: The species appears to have been introduced into Australia at the end of the 19th century and while local strains have developed (Quinlivan 1965), the species is, on the whole, one of the less variable annual species. The description is mainly based on plants sold by seed firms as 'Snail medic'.

Description: Stems, petioles and peduncles densely covered with simple and glandular hairs. Central leaflets 15-22 mm long, 10-15 mm broad, oval, obovate or oblanceolate, apex obtuse only in lowest leaves, mainly acute, upper ⅔ of leaf margin serrate, upper surface with rare purple fleck or none, glabrous, lower surface with dense glandular and simple hairs. Stipules with small sharp teeth, glandular hairs on upper side, (cf. Heyn 1963) glandular and simple hairs on lower side. Peduncle shorter than the subtending petiole, with a long (± 5 mm) hairy awn. Flowers 1-2(3) per raceme; calyx with dense simple and glandular hairs, teeth equal to or longer than the tube, standard 6-7 mm long, keel very slightly longer than wings. Developing pod contracted and protruding sideways from the calyx (or sometimes contained in the calyx), anticlockwise coiling. Mature fruits 1-2(3) per raceme, spineless, cup-shaped or olive-shaped, 11-14 mm diameter, 11-16 mm high, 5-7 coils, basal coils enclosing upper ones, dense glandular and simple hairs when young, exposed parts ± glabrous at maturity. Radial

veins distinct, reticulate, no lateral veins. Seeds 4-6, none in the distal 2-3 coils, separated by very thin partitions, reniform, not glossy, yellow or brownish yellow, 4-6 mm long, 2½-3½ mm broad, radicle less than half the length of the cotyledons, tip projecting, hilum distinct. 2n=32.

Common name: 'Snail medic', which refers to the pod shape.

Cultivars: None.

Distribution: Rarely cultivated and apparently not naturalised in Western Australia.

Medicago tornata (L.) Mill., Gard. Dict.

ed. 8 : No. 3 (1768)

Synonymy: *M. obscura* Retz., emend. Urb., Verh. bot. Ver. Brandenb. 15: 66 (1873).

Australian representation: *M. tornata* does not occur in naturalized populations in Western Australia, the specimen reported by Quinlivan (1965) from Ravensthorpe being an incorrectly identified spineless *M. truncatula*. The cultivar Tornafield is attributable to *M. tornata* var. *tornata*, and although cv. Murrayland is possibly of hybrid origin, having some *M. littoralis* features, it is best also referred to var. *tornata*. The source material for cv. Murrayland is naturalized at Pooncarie, N.S.W.

Description: Stems, petioles and peduncles with sparse simple hairs. Central leaflets 10-17 mm* long × 9-16 mm wide, obovate, angular obovate, or oblanceolate, apex obtuse, apiculate, upper 2/3 of leaf margin serrate, upper surface glabrous or sparsely hairy, lower surface sparsely hairy. Leaves may have purple and white flecks, and rarely, a narrow ellipsoidal purple mark on the upper surface. Stipules deeply incised, moderately dense hairy on lower side only. Peduncle markedly longer than petiole of subtending leaf (up to twice as long in flower), awn up to 4 mm long with a few hairs. Flowers (4)7-10(15) crowded in the inflorescence, calyx with moderately dense hairs mostly at the base of the teeth, teeth longer than the tube. Standard 5-8 (10) mm long, keel longer than the wings. Developing pod contracted and concealed in the calyx or sometimes protruding sideways coiling anticlockwise (in the Australian cultivars). Mature fruits 4-8 per raceme, discoid, cylindrical or a truncated cone 4-7 mm wide (up to 10 mm wide reported in original description of cv. Tornafield) × 2-7 mm high, spineless, glabrous, 2-5 convex coils, appressed only in the centre in cv. Tornafield, and right to the outer edge in cv. Murrayland. Venation difficult to see at maturity, surface of coil with about 10 radial veins which anastomose into a net, and run into lateral veins separated from the dorsal suture, no groove between the dorsal suture and lateral veins, edge of coils smooth. Seeds 3-6 per pod, separated by thick partitions, subreniform to strongly reniform, yellow or yellow-brown, 2½-4 mm long × 1½-2¾ mm wide, radicle less than half the length of the cotyledons, tip appressed. 2n = 16.

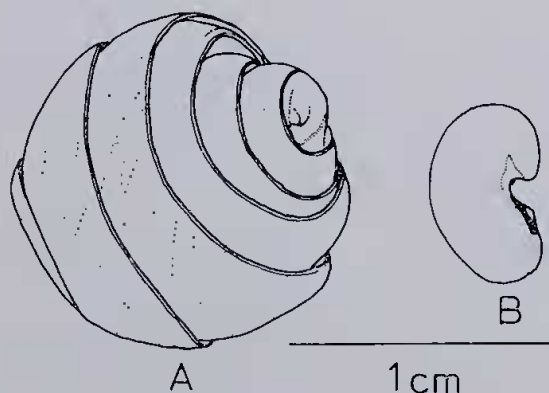


Figure 14.—*Medicago scutellata*. A: burr (hairs not shown). B: seed.

* Leaves up to 30 mm long and 20 mm wide are reported by Millington in the description of the cv. Tornafield (Barnard 1972) but I have not seen leaves of this size.

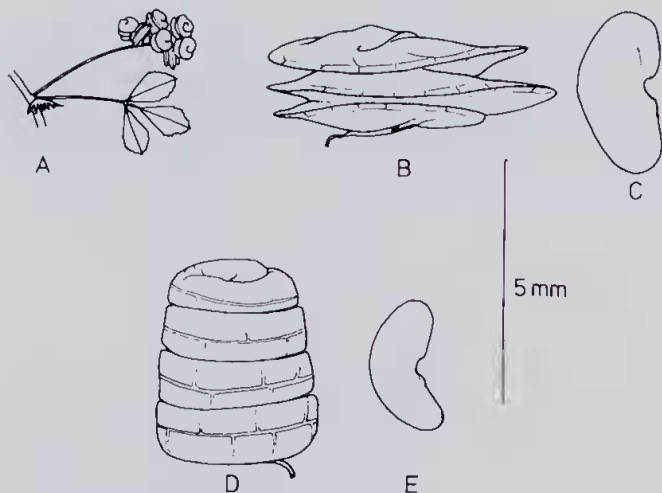


Figure 15.—*Medicago tornata*. A-C: cv. Tornafield. A: leaves (hairs not shown) and burrs. B: burr. C: seed. D and E: burr and seed of cv. Murrayland.

Common name: "Disc medic", chosen by the W.A. Herbage Liaison Committee to describe the fruit of cv. Tornafield which sometimes looks like a series of discs. Barnard has attempted to change this common name to sand medic, arguing that disc medic might be confused with *M. disciformis* DC. and in any case cv. Murrayland has cylindrical rather than disc-shaped burrs.

Cultivars: cv. Tornafield. This was derived from selection among and F_2 of a cross between var. *tornata* and var. *aculeata*, selection being aimed at combining the large burr size and absence of spines of the *tornata* accession with the early flowering of the *aculeata* accession. The number of pod coils in cv. Tornafield is 2-3½ which is at the lower limit of the range observed in naturally occurring var. *tornata* (3-6(8) coils). However in view of the parentage, cv. Tornafield can be included in var. *tornata*.

cv. Murrayland. These plants show some features of *M. tornata*, most importantly the many-flowered inflorescence (4-6 flowers) which has a peduncle much longer than the petiole of the subtending leaf. However the pods of cv. Murrayland are typical of *M. littoralis* var. *inermis* in their cylindrical shape with the coils appressed to the extreme edge, and with the lateral veins at the very edge of the coil in the same plane as the dorsal suture. Heyn (1963) considers that the flower characteristics outweigh the burr morphology and places material such as this in *M. tornata* but notes that introgression with *M. littoralis* has occurred. Similar specimens come from the west Mediterranean and are frequently identified as *M. striata* Bast. The fruits of cv. Murrayland are quite distinctive and cannot be confused with pods of any other naturalised or cultivated species in Australia at present.

Distribution: No naturalized occurrence as yet, but it is likely that the cv. Tornafield introduced in 1969 will soon establish naturalized stands along roadsides in the Geraldton district.

***Medicago truncatula* Gaertn., emend. Urb., Verh. bot. Ver. Brandenb. 15:67 (1873)**

Synonymy: *M. tribuloides* Desr., in Lam., Encycl. Method. 3:635 (1792).

Australian representation: Most of the naturalized material and the cvs. Cyprus, Jemalong and Hannaford are var. *truncatula*, or intermediate between vars. *truncatula* and *longiaculeata* Urb.; cv. Ghor is var. *longiaculeata* Urb., and cv. Borung is var. *tricycla* (Negre) Heyn or intermediate between that variety and var. *truncatula*. The spineless form has not been described as a variety. Heyn (1963, 1970) also notes that intermediate forms occur, and it has been observed that at the beginning of the season a plant may form burrs with thick, straight, strongly appressed spines typical of var. *truncatula*, but burrs formed later may have thinner, curved spines not strongly appressed more like var. *longiaculeata*.

Description: Stems, petioles and peduncles with dense simple hairs. Central leaflets 6-20(25) mm long \times 5-14(20) mm wide, cuneate or obovate, apex obtuse, truncate or retuse, apiculate, margin serrate along upper 1/3 surface sparse to densely hairy, lower surface always densely hairy. Upper surface with or without purple flecks, a large central ellipsoidal purple mark, or a small upper central yellow mark faintly bordered with purple. Stipules dentate to deeply dentate, with sparse to dense simple hairs on lower side only. Peduncle usually shorter than petiole in both flower and fruit, a hairy awn up to 5 mm long. Flowers 1-3(4) per raceme, calyx densely hairy, *teeth much longer than the tube* with the 3 anterior teeth sometimes slightly longer than the posterior ones. Standard 4½-7 mm long, keel just longer than the wings. Developing pod contracted and concealed in the calyx or protruding sideways, coiling clockwise or anticlockwise. Mature fruits 1-2 (4) per raceme, a short or long cylinder or a truncated cone, 3-7 coils strongly appressed and thickened at maturity, 4½-8 mm* diameter, 4½-11 mm high*, usually pubescent especially when young, rarely almost glabrous. About 10 radial veins anastomosing and entering a *lateral vein* which is on the surface rather than the edge of the coil, and *which is separated from the dorsal suture by a groove* (particularly marked on young burrs and occasionally obliterated in very thickened mature burrs), spines lacking, short or long (up to 3 mm), straight or curved, base with or without a short groove, sometimes with base very thickened, inserted at 90° to 120°. Seeds (3)4-8(12), separated by thin partitions, subreniform to reniform, yellow to brownish-yellow, 2½-4 mm long* \times 1½-2½ mm broad, radicle less than half the total length of the cotyledons, tip appressed. $2n = 16$.

Common name: "Barrel medic" which refers to the pod shape.

Cultivars: The main features of the six cultivars are:

cv. Hannaford (previously 'Commercial barrel medic' or 'South Australian barrel medic'):

* The registration description of cv. Cyfield gives the upper limit of pod diameter 12 mm, pod height as 15 mm, and seed length 6 mm. I have not seen material in this size range.

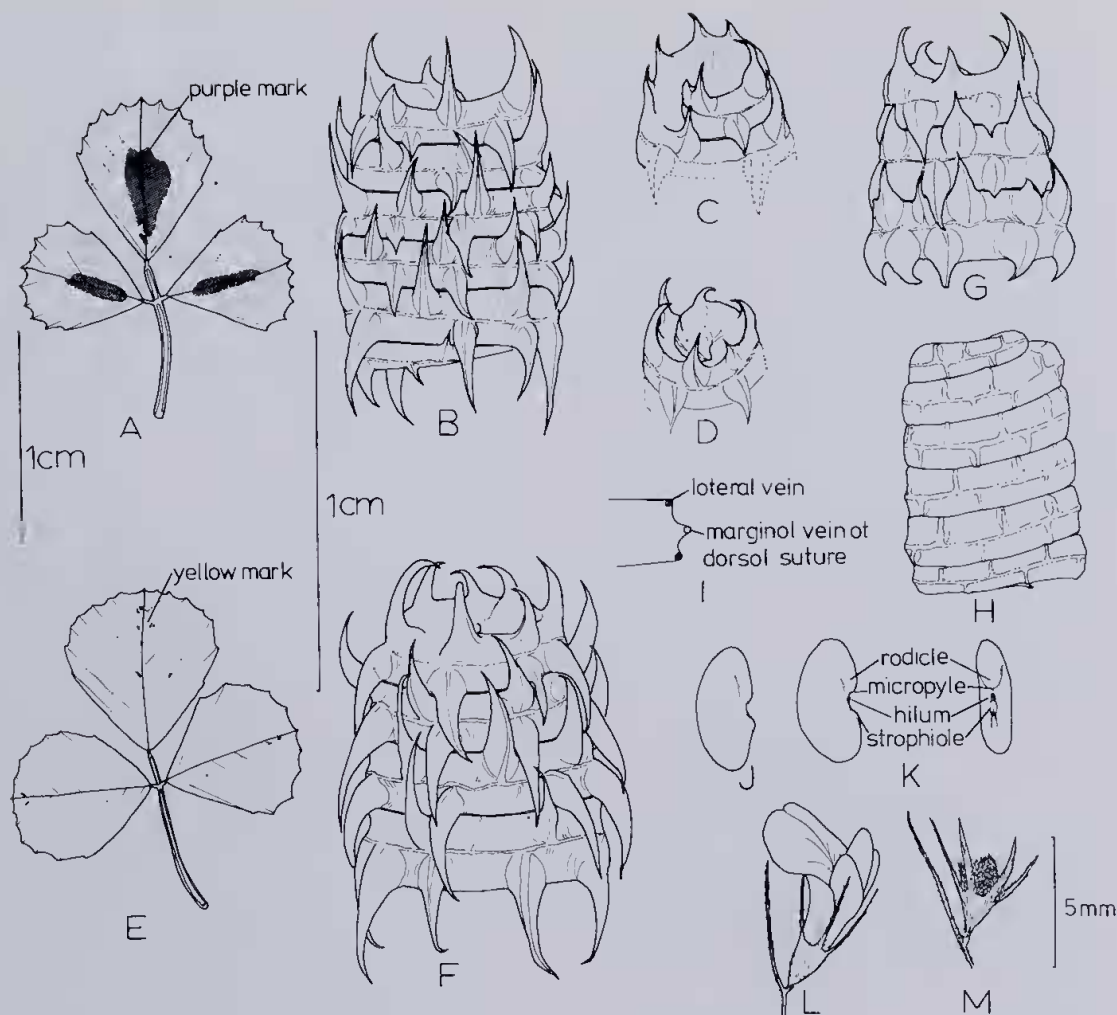


Figure 16.—*Medicago truncatula*. A-C: cv. Jemalong. A: leaf. B: burr. C: apical coils showing anticlockwise coiling. D: cv. Cyprus apical coils showing clockwise coiling. E and F: cv. Ghor leaf and burr. G: cv. Borung burr. H: cv. Cyfield burr. I: diagrammatic T.S. of coil edge. J: cv. Cyprus seed. K: cv. Cyfield seeds. L: flower. M: developing fruit (hairs on leaves and burrs, except M, not shown).

variable burr types with spines strongly appressed or not so. Mainly clockwise, some anticlockwise, coiling. Burrs of this cultivar comparable in size with cv. Cyprus and cv. Jemalong: 7-10 mm high \times 4½-6 mm wide.

cv. Cyprus: burrs with strongly appressed spines, clockwise coiling. Indistinguishable botanically but earlier-flowering than similar types in cv. Hannaford.

cv. Jemalong (previously '173') large purple central ellipsoidal leaf mark, burrs with strongly appressed spines, anticlockwise coiling.

cv. Cyfield: a spineless cultivar with large pods (6-11 mm high), large seeds (up to 4 mm long), and both clockwise and anticlockwise coiling burrs.

cv. Borung: small burrs (4-6 mm high) with 2-3½ anticlockwise coils, short spines, 3-4 fruits per raceme.

cv. Ghor: leaves with an upper central yellow mark sometimes bordered with purple-brown. Burrs large, woody, anticlockwise coils, large spines up to 3½ mm long, not appressed, seeds large.

Distribution: *M. truncatula* was naturalised in other states before the introduction of the cultivars. In PERTH there is only one specimen of a spiny barrel medic—from Hopetoun in 1932, which predates the introduction of the spiny cultivars, and a spineless one from Ravensthorpe in 1963 pre-dates the introduction of cv. Cyfield. Despite the lack of herbarium records, it is thought that the species was naturalized over a wide area: Merredin, Leonora, Kalgoorlie, Salmon Gums, before the 1950's (Quinlivan, pers. comm.).

Naturalized material from cv. Hannaford, Cyprus, and rarely Jemalong, is common in the drier cereal and sheep areas, particularly from Merredin to Southern Cross but may also be found along roadsides as far north as Shark's Bay and Laverton and south east to Salmon Gums. The other cultivars, Cyfield, Borung and Ghor, are recent registrations as yet little used in Western Australian agriculture, and not recorded from naturalised populations.

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